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Samples of Students' Responses

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from the
Grade 9 Mathematics Performance-Based Assessment Tasks June 1992

Students First!
Student Evaluation

Alberta
EDUCATION

Samples of Students' Responses

from the

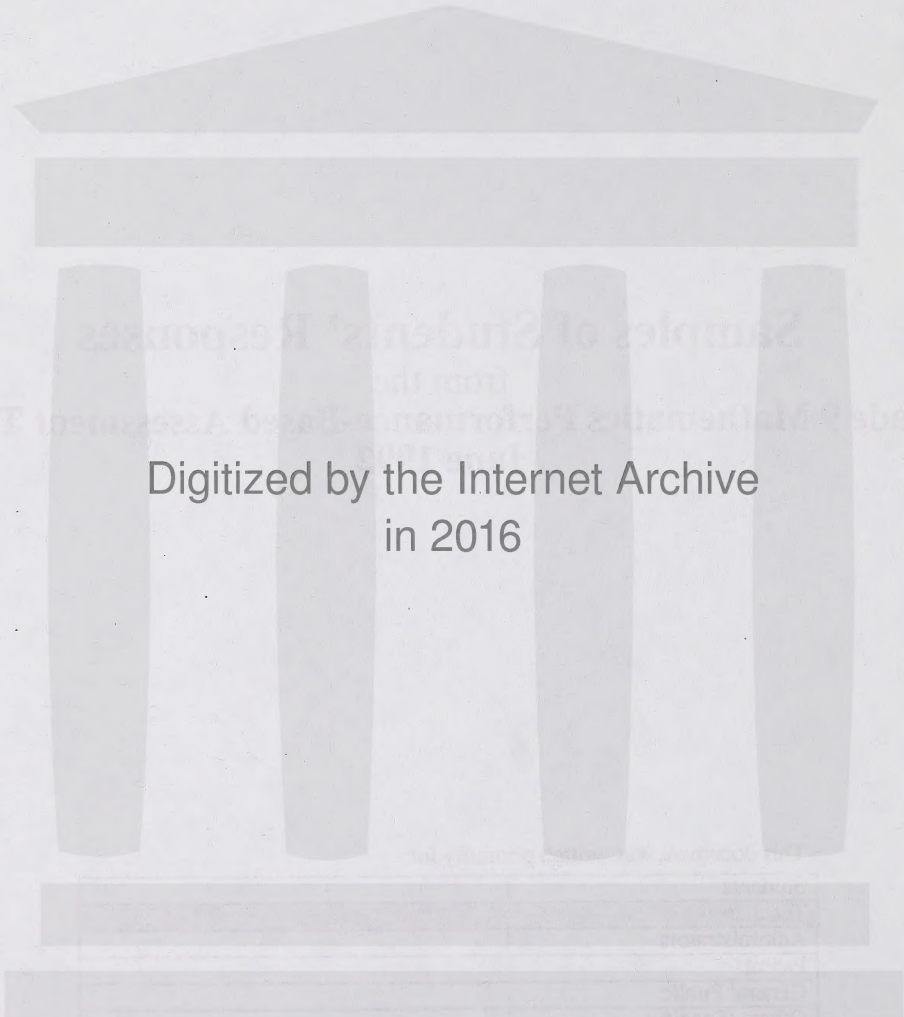
Grade 9 Mathematics Performance-Based Assessment Tasks

June 1992

This document was written primarily for:

Students	
Teachers	
Administrators	
Parents	
General Public	
Others (Specify)	

Alberta Education
Student Evaluation Branch



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Introduction

Purpose of this Booklet

The purpose of this booklet is to provide teachers, administrators, students, and parents with samples of students' performances that exemplify standards in relation to the 1992 Grade 9 Mathematics Performance-Based Assessment Tasks. The commentaries that accompany the samples highlight selected features of the students' responses and show how the scoring criteria relate to students' work.

Mathematics Assessment in 1992

The Grade 9 Mathematics assessment in 1992 collected and reported on a range of learning expectations. Three strategies were used to collect this information: the achievement test, a survey of student attitudes, and performance-based assessment tasks. Provincial results are reported fully in the *Achievement Testing Program Provincial Report, June 1992 Administration*. The performance-based assessment component is the specific focus of this booklet.

Selection of Samples

The samples of students' work selected for this booklet were used for training markers during the July 1992 marking session. As such, these examples generally illustrate the quality of students' work at each of three levels: Beyond Grade 9 Level, At Grade 9 Level, and Not Yet At Grade 9 Level.

Confirming Standards

The initial work of confirming the standards that would govern the scoring of student performances was undertaken by a group of experienced Grade 9 Mathematics teachers on July 2 and 3, 1992.

Their task was to read a large enough sample of student responses to select those that exemplified the different levels of performance. In addition, the teachers suggested adjustments to the scoring guide where needed and prepared specific notes for use during the marking session.

These teachers also served as group leaders during the marking session. They used the selected examples to set the scoring guidelines and to train teachers for the marking session.

Marking Session

Teachers were selected for marking on the recommendation of their superintendents. All markers were teaching Grade 9 Mathematics in the same school year the performance-based assessment was administered and had done so for at least two years.

Markers followed agreed-upon standards when scoring student responses. During the marking session, each marker scored a student's response for problem-solving skills and communication skills. Strategies for judging communication went beyond just written statements—teachers considered organization and presentation of data, use of diagrams, use of symbolism, or other strategies that a student might have used in preparing a response.

Acknowledgments

This booklet would not have been possible without the student writers who kindly granted us permission to publish their work. As well, the valuable contributions of several teachers and Student Evaluation Staff were appreciated:

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General Description of the Performance-Based Assessment

Background

The performance-based assessment was developed to assess students' higher order thinking skills in real-life problem-solving situations. The tasks assessed aspects of mathematics that cannot be easily measured by paper-and-pencil tests.

The activities allowed students to use a variety of strategies, to use manipulatives, and to collect data. Students used manipulatives in solving the problems and in collecting information. Students were asked to explain the strategies they used and how they carried out these strategies to solve problems. Their written responses provided another picture of what they knew and were capable of doing.

Brief Description of Each Assessment Activity

	Name	Content Area	Learning Expectation/Skill Area		Name	Content Area	Learning Expectation/Skill Area
1	Seating Place	Numeration Measurement	Analysis of Problems Use of a Model Use of Factors Relation between Perimeter and Area	2	Highway to Mathematics	Measurement Ratio and Proportion	Application of Measurement Use of Proportion Use of Map Legend
3	Solar Cylinder	Geometry Measurement Operations	Application Analysis Synthesis—Subproblems Use of Measuring Skills Finding Area Checking Reasonableness of Answer	4	Ski Jumping	Data Collection Data Management Numeration	Data Collection and Recording Display of Data Analysis of Data Interpretation of Data
5	Bucket of Beans	Measurement	Analysis Estimation Checking Reasonableness of Answer	6	Packaging	Numeration	Analysis Monitoring Use of Factors Finding Greatest Common Factor

Sampling

Twenty-two schools were randomly selected to participate in this assessment. From these schools, 528 students were randomly selected; of these, 504 did the performance-based assessment. Students who were absent were not asked to participate in make-up sessions.

Administration

This assessment was administered by trained assessors who followed standard procedures. The assessment consisted of six real-life problems presented at six stations. Each station consisted of:

- a student activity sheet listing the problem, materials that may be used, and instructions
- materials
- a student recording booklet

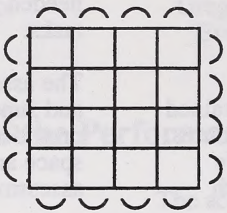
Three circuits, each with six stations, were set up. A maximum of 15 students were assigned to each session and given as much time as necessary to complete the tasks. This allowed for five students to work through the six activities at each circuit. Typically, between 1.5 and 2 hours were needed for each student to complete the six tasks.

The assessment took place between May 11 and June 2, 1992. The schools selected provided excellent cooperation in making space and tables available for this assessment.

Samples of Students' Performance

Activity 1: Seating Place

Problem: There are sixteen students on the Elmo Junior High School Council. When the Student Council has a meeting, sixteen small square tables are arranged to form a large square, so that each member will have a place to sit.

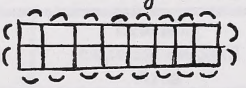


The students at Elmo Junior High School elected four additional students to the Student Council. How can the members rearrange the sixteen tables into a new rectangular shape **with no holes in the middle** so that all twenty people will have a place to sit, and no seats will be empty?

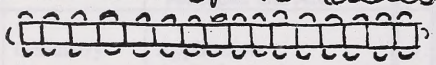
Materials: 16 squares (4 cm x 4 cm)

This solution was scored "Beyond Grade 9 Level."

1. How can the members rearrange the sixteen tables to seat 20 students? Instead of arranging them in 4 rows of 4, they can rearrange the tables in 8 rows of 2, like this:

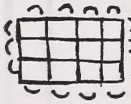


2. What is the greatest number of students that can be seated at sixteen square tables arranged in a rectangular shape at the council meeting? Draw the arrangement. State how many can be seated. 34 students can be seated if you place the tables in a row of 16 tables.

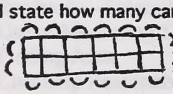


3. If you had 12 tables, how many different size groups could be seated? Draw all these arrangements and state how many can be seated.

12 x 1
3 x 4,
6 x 2

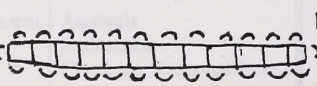


If you had 3 by 4 tables, you could seat 14 people.



If you made 2 by 6 tables, you could seat 16 people.

12 cannot be divided into any more numbers, so I cannot make any more rearrangements

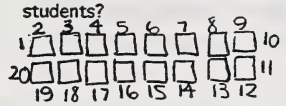


If you had one long table of 1 by 12, you can seat 26 people.

The problem was analyzed and readily understood. The student understood "rectangular shape" and "no holes in the middle." The student provided evidence of efficient and workable strategies by showing factors of 12 and 16 and by drawing diagrams. As well, there was explicit evidence that the strategies were carried out, i.e., the student showed the number of chairs around the tables. All possible arrangements were given. Conclusions were related to the questions asked and were given in clear, complete sentences in context.

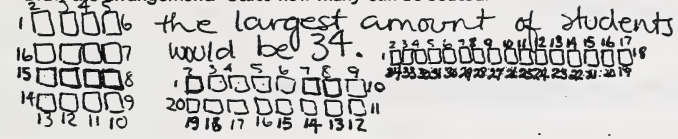
This solution was scored "At Grade 9 Level."

1. How can the members rearrange the sixteen tables to seat 20 students?

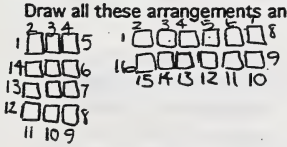


2. What is the greatest number of students that can be seated at sixteen square tables arranged in a rectangular shape at the council meeting? Draw the arrangement. State how many can be seated.

the largest amount of students would be 34.



3. If you had 12 tables, how many different size groups could be seated? Draw all these arrangements and state how many can be seated.



The problem was analyzed and understood. The student understood "rectangular shape" and "no holes in the middle." The student provided evidence of a strategy by drawing diagrams. However, in question 3, one possibility was omitted. As well, there was only one statement connecting the answer to the question asked. Questions 1 and 3 lacked statements but did have numerical values.

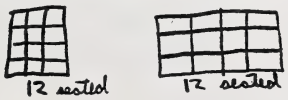
This solution was scored "Not Yet At Grade 9 Level."

1. How can the members rearrange the sixteen tables to seat 20 students?

2. What is the greatest number of students that can be seated at sixteen square tables arranged in a rectangular shape at the council meeting? Draw the arrangement. State how many can be seated.

They can sight 16 students.

3. If you had 12 tables, how many different size groups could be seated? Draw all these arrangements and state how many can be seated.



There is only one way to seat people at 12 tables.

The problem was only partially understood. The student either did not understand "rectangular shape" or did not attend carefully to the problem posed. This resulted in an inappropriate response to question 2. As well, the student did not show all possibilities for question 3. Statements relating the answer were made for two out of the three questions asked.

Activity 2: Highway to Mathematics

Problem: Paul is working for Parks Canada in Jasper during the summer. One of his assignments is to check the accuracy of park maps given to visitors. Today, Paul is going to check the distance CI and BE on the map (see Appendix A) by travelling in his car. First he wants to check the distances on the map. Help him to do this.

Materials: map
ruler
compass
penny (polygon type)
copper wire (very fine and flexible)

This solution was scored "Beyond Grade 9 Level."

1. Find the actual distance from C to I. Find the actual distance from B to E. Show all your work and explain how you did it.

C to I - I took the copper wire out of the bag and layed it down, along the road on the map between C and I. This way I had the shape of the road on the wire. I then straightened the wire, and marked where C and I were.

This way, I had the distance from C to I on a straight line that could be measured easily I then measured the distance on the wire. It was 7.5 cm. The legend says 2cm = 1km So I was able to calculate it easily from there.

$= \frac{2\text{cm}}{1\text{ km}} = \frac{7.5\text{cm}}{x\text{ km}}$ x=distance from C to I.

$= 2x = 1 \times 7.5$

$= 2x = 7.5$

$\frac{2x}{2} = \frac{7.5}{2}$ $x = 3.75\text{km}$

The distance between point C and point I is 3.75km

The problem was analyzed and readily understood. The student developed an efficient and workable strategy. The copper wire was used to measure the length. In question 3, the student correctly used the coin and its circumference. There was explicit evidence of carrying out the strategy. This student laid out the wire along the path and converted measured distance to actual distance. The information was synthesized and a conclusion given in context.

Distance from B to E

I repeated each individual procedure from C to I carefully, laying out the wire, measuring it, and calculating the distance. The measure of the wire was 14cm.

$$\frac{2cm}{1km} = \frac{14cm}{Xkm}$$

$$2x = 1x14$$

$$2x = 14$$

$$\frac{2x}{2} = \frac{14}{2}$$

$$x = 7$$

The distance between point B and point E is 7km.

This student used both written communication and mathematical calculations in an effective way in solving the problem. The written work was clear and the calculations correct.

2. Is your answer reasonable? Explain why or why not.

My answer is reasonable. This distance on the road seems to corespond with the distance on the legend. This shows to me that my calculations are close to, or excacty correct

The student clearly explained the reasonableness of the answer. As well, the responses to questions 3 and 4 indicate that this student was aware that alternative strategies can be used to solve the problem.

3. What other way can you solve this problem, using any of the materials provided?

Use the penny. Simply continue to flip it over, count how many times I fliped it and multiply that number by the diameter of the penny

4. How would you solve this problem without using the materials provided?

I would estimate by using my fingers as measuring devices.

This solution was scored "At Grade 9 Level."

1. Find the actual distance from C to I. Find the actual distance from B to E. Show all your work and explain how you did it.

C-I - I took the copper wire and followed the route from C-I after I straightened the wire and measured it on a cm ruler. After that I looked at the scale and measured it with the cm ruler. It represented that 2cm = 1km since the measurement came out to 6.8cm I multiplied it by 2 and got 13.6km is the distance from C-I.

B-E cm reading - 13.5cm × 2
= 27km

The problem was analyzed correctly and understood. The scale was interpreted correctly. The student used and explained a workable strategy, i.e., the copper wire. Results from the measurement were very accurate, but the conversion to actual measurement was incorrectly done.

2. Is your answer reasonable? Explain why or why not.

yes in my opinion I think it was because copper wire was a good thing to use.

The student explained the appropriateness of the strategy but did not answer the question about the reasonableness of the answer.

3. What other way can you solve this problem, using any of the materials provided? Using the compass and measuring it by putting it up close to the ruler and repeat if any curves are hit.

This student recognized that there are other ways to solve the problem and briefly explained how this might be done. Problems that might be encountered using different strategies were also cited.

4. How would you solve this problem without using the materials provided? Difficulty but with a ruler and following the line, it would not be very accurate.

This solution was scored "Not Yet At Grade 9 Level."

Show all your work by answering these questions so that Paul can understand how these results were obtained.

1. Find the actual distance from C to I. Find the actual distance from B to E. Show all your work and explain how you did it. from C to I it is 7½ Km the way I found that out is I took the smallest wire and I followed the road and measured how far it was on the wire. the distance from B to E is 14½ Km. the way I found it out is that I took a wire and found out how long it was on the wire and measured the wire.

The task was understood. The student developed a workable strategy to solve the problem but, in converting, the measurement was based on an incorrect assumption that 1 cm = 1 km. The plan was not carried out successfully; thus, a reasonable answer was not found.

2. Is your answer reasonable? Explain why or why not.
Yes, my answer is reasonable because I am very good at math and also it was very easy.

The support for reasonableness was not based on sound mathematical reasoning. Although an alternative strategy was suggested, the explanation lacks detail.

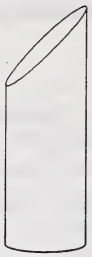
3. What other way can you solve this problem, using any of the materials provided? You could use the compass to measure the distance.

4. How would you solve this problem without using the materials provided? I wouldn't be able to do it without the materials.

Activity 3: Solar Cylinder

Problem: Adam owns a company that makes solar cylinders. He needs to know the shape and surface area of the label to send to the graphics department. Help him find out what shape, size, and area the label should be.

Hint: The label covers the whole lateral surface of the cell.



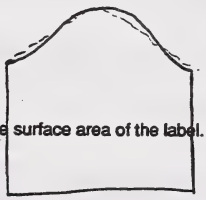
Materials: solar cylinder
paper
scissors and scotch tape
pencil and ruler
calculator

This solution was scored "Beyond Grade 9 Level."

1. Explain your method for finding the shape of the label needed for the solar cylinder.

I wrapped paper around the solar cylinder to make a lable and cut it out.

It looks like this:



2. Explain how you would find the surface area of the label.

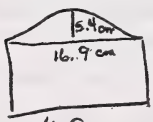
① find the measurements

② times them together

3) find the surface area of this. it is a rounded triangle or maybe find it like a triangle. (b×h÷2)

4) Add them together to get the total.

3. Find the surface area of the above label. Show all your work.



= 162.24cm²
+
= 45.63cm²
=
= 207.87cm²

or

208 cm²

The problem was analyzed and readily understood. The work shows an understanding of lateral surface area. The student used an efficient and workable strategy. The wrapping method conveyed the shape and size of the label. The process was communicated clearly and the calculations were carefully done. The student provided explicit evidence of carrying out the strategy in diagrams and explanations. The solution was given in context with correct units of measure.

This solution was scored "At Grade 9 Level."

1. Explain your method for finding the shape of the label needed for the solar cylinder.

First tape the a piece of paper around the solar cylinder. Make sure the bottom of the paper is ~~top~~ lined up with the bottom of the solar cylinder. Take sharp scissors & cut paper even with the top of the solar cylinder, all the way around. Then Take paper off & you have the shape of the label.

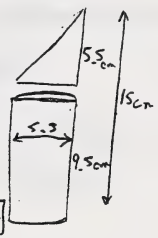
The problem was analyzed and well understood. The student developed a workable strategy and provided explanations in questions 1 and 2.

2. Explain how you would find the surface area of the label.

A solar cylinder is a cylinder & half another one.
3.14 x diameter x hight = surface area.
3.14 x diameter x hight ÷ 2 = surface area.
Add them together & you have the surface area.

The method for finding the surface area was correct in all aspects.

3. Find the surface area of the above label. Show all your work.



3.14 x 5.3cm x 9.5 = 158.099cm²
total hight is 15 - 9.5 = 5.5
3.14 x 5.3 x 9.5 ÷ 2 = 79.0495cm²
158.099 + 79.0495 = 237.1485cm²
The surface area of the label is 237.1485cm².

Evidence was shown in question 3 that the student carried out the plan correctly. However, an error was made in calculating the half cylinder even though the measurements were correct (the student used 9.5 instead of 5.5). The solution was related to the context of the problem. However, because of the calculation error, the answer was outside the acceptable range.

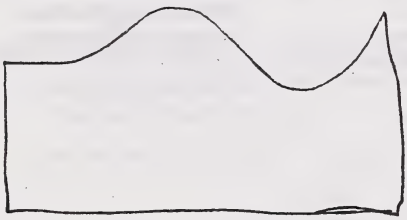
This solution was scored "Not Yet At Grade 9 Level."

1. Explain your method for finding the shape of the label needed for the solar cylinder.

wrap it around with paper, and then cut it out

The problem was analyzed and partially understood. The student gave no clear explanation of a workable strategy.

2. Explain how you would find the surface area of the label.



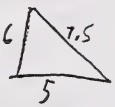
The sketch in question 2 suggests that the wrapping method was attempted but overlapping of the paper gave more area than necessary. There is no indication of how the wrapping method is related to calculating the surface area.

3. Find the surface area of the above label. Show all your work.

$3.1 \cdot 5.35 = 16.8$

$16.8 \times 10 = 168$

$+ 112.5$



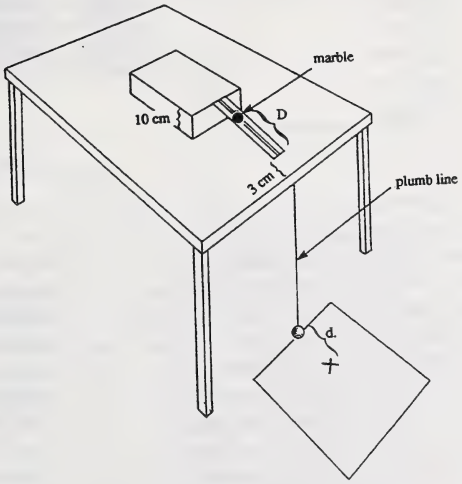
$= 112.5$

280.5cm

The answer has incorrect units and does not relate to the question asked.

Activity 4: Ski Jumping

Problem: What is the relationship between the distance a ski jumper moves down the slope of a ski jump and the distance he travels horizontally before he lands? A 30 cm ruler with a groove down the middle is set up as shown. The lower end is 3 cm from the edge of the desk. A marble is rolled down the ruler from different positions. It hits the paper on the floor.



Vary the distances for D—3 cm, 9 cm, 15 cm, 21 cm, 27 cm. Measure the distance for each d.

Materials: 30 cm ruler with a groove down the middle
marble
plumb line
large sheet of paper
measuring ruler

This solution was scored "Beyond Grade 9 Level."

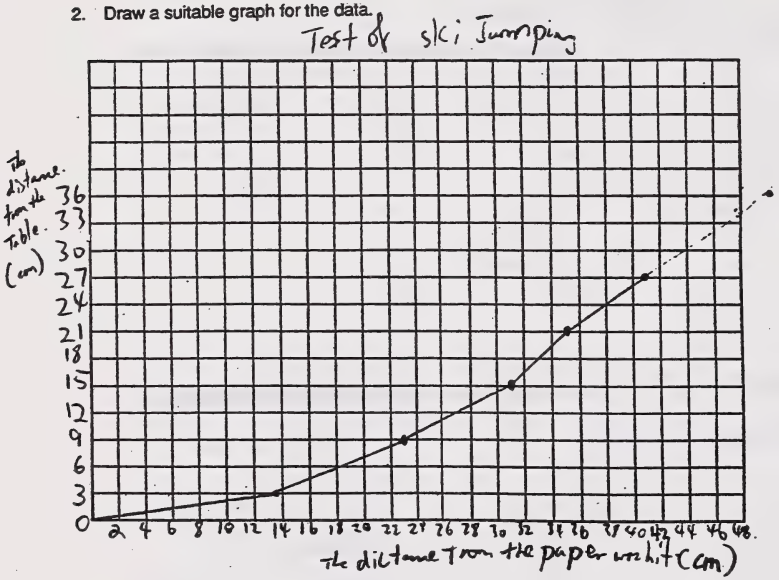
1. Plan and record the data in some suitable way.

Title. test of ski Jumping

The distance from the table (cm)	the distance from the paper was hit (cm)
3cm	13.5cm
9cm	23cm
15cm	29cm
21cm	35 cm
27cm	41.6 cm

The problem was analyzed and readily understood. The student collected and displayed data using appropriate labels.

2. Draw a suitable graph for the data.


Test of ski Jumping
The distance from the table (cm)
0 3 6 9 12 15 18 21 24 27 30 33 36
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48
The distance from the paper was hit (cm)

A line graph was appropriately used for continuous data and extrapolation was indicated by extending the graph. A suitable scale was used for the graph, and all components were labelled correctly.

3. From the graph, predict the distance d when D is 36 cm.

It will be 51cm.

A suitable prediction was derived by extrapolating from the graph.

4. How could you modify the ruler so that you can increase d?

I will put the ~~red~~ ruler higher. If I can increase d. Because the ruler get higher. The angles of rule will go up. And the ball will go faster and d will increase.

The student gave a good explanation as to how the ruler would be modified. A small diagram was used to further support the explanation.

This solution was scored "At Grade 9 Level."

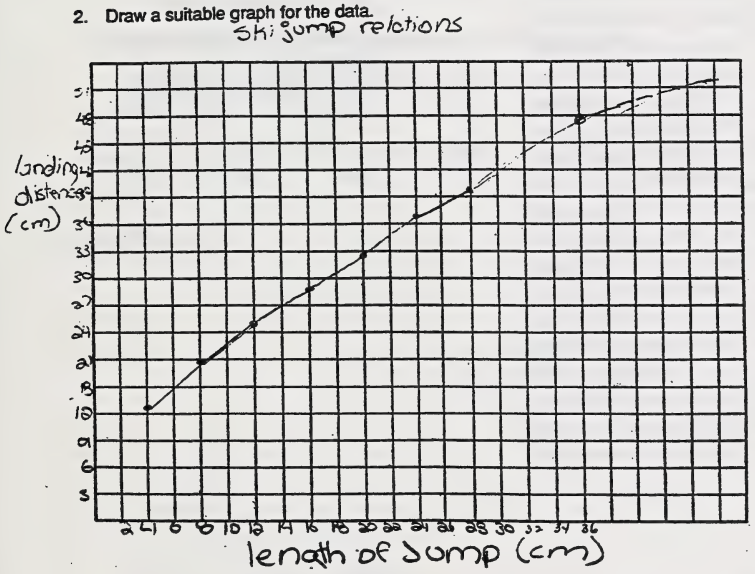
1. Plan and record the data in some suitable way.

Data Chart

length of ski jump	1	2	3	Ave
4 cm	13.2	12.4	12.9	12.9
8 cm	20.8	21	20.9	20.9
12 cm	23.6	23.6	26.9	25.6
16 cm	26.2	28.5	28.7	28.5
20 cm	33.5	32.5	32.9	32.9
24 cm	36.4	36.3	36.5	36.3
28 cm	39.8	39.8	39.7	39.8

The problem was understood. The student collected and displayed data in a suitable format. The chart and graph were labelled.

2. Draw a suitable graph for the data.



A line graph was appropriately used for continuous data. However, the student made errors in labelling, scaling, and plotting the graph.

3. From the graph, predict the distance d when D is 36 cm.

d = 48 cm

An acceptable prediction was derived through extrapolation from the graph.

4. How could you modify the ruler so that you can increase d?

The student made no attempt to answer question 4.

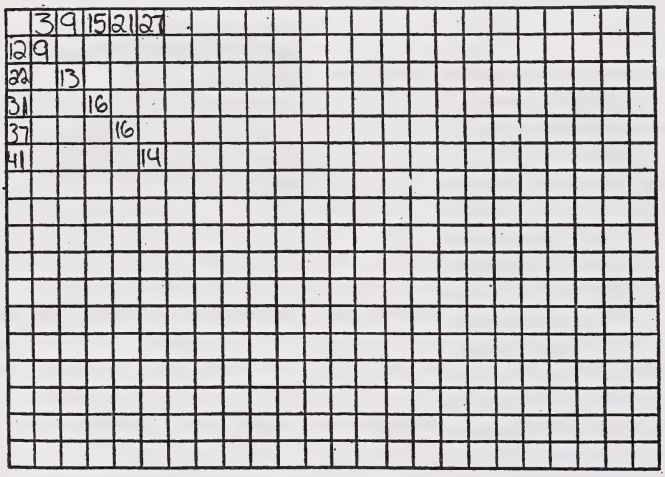
This solution was scored "Not Yet At Grade 9 Level."

1. **Plan and record the data in some suitable way.**

3 - 12
9 - 21.5
15 - 30.5
21 - 36.5
27 - 41

The data collected suggest that the problem was partially understood, but the data were poorly displayed with no labels or meaningful organization.

2. **Draw a suitable graph for the data.**



The student did not draw a suitable graph for the continuous information. No labelling appears on the graph.

3. **From the graph, predict the distance d when D is 36 cm.**

I predict the distance will be about 47 cm.

The prediction was within an acceptable range, but how this was obtained is not clear.

4. **How could you modify the ruler so that you can increase d?**

I would make more of slope, over a shorter distance. and add a lip at the bottom

This is how it is now

This is what I would do to increase the d.

An acceptable explanation of how the ruler could be modified was given in this solution.

Activity 5: Bucket of Beans

Problem: Estimate the number of beans in the bucket.

Materials: large bucket of beans
magic markers
tray
small cup

This solution was scored "Beyond Grade 9 Level."

1. Explain the strategy you used to estimate the number of beans.

To estimate the number of beans, I filled a cup with 100 beans, found a mark between the highest & lowest filled on the cup, marked it kept filling to that point. I kept a tally (1 = 100 beans) & multiplied that by 100.

𝍸 𝍸 𝍸 ||||

The problem was analyzed and readily understood. The student clearly described an efficient and workable strategy. The student provided explicit evidence of carrying out the strategy by using a cup to determine estimates. The uniqueness of this solution was in using 100 beans (an excellent estimating number). There is indication of tallying for recording the number of 100 bean cups.

2. About how many beans are there in the bucket?

18.5
×100
1850

There are about 1850 beans in the bucket.

The numbers used (18.5 and 100) are such that the answer was arrived at by mental computation. The answer was well within the acceptable range (1600–1900).

This solution was scored "At Grade 9 Level."

1. Explain the strategy you used to estimate the number of beans.

I placed 185 beans in the magic cup. Hoping that the same number of beans will complete full the cup. I measured that 9½ cups to empty the bucket

cups
½

$185 \times 9.5 = 1757.5$

The problem was understood and the student provided a workable strategy. However, it is evident from the way the plan was carried out that the meaning of estimation was not clear to the student. Exact calculation, rather than rounding and mental computation, was used to arrive at an answer.

2. About how many beans are there in the bucket?

So there about are 1757 beans in the bucket

The answer was within the acceptable range of 1600–1900 and was correctly related to the question.

The solution was scored "Not Yet At Grade 9 Level."

1. Explain the strategy you used to estimate the number of beans.

I filled up one cup full, counted them, found out how many cups could be filled, and multiplied

The problem was understood and a workable strategy was decided on, but the student did not carry out the plan successfully. An early error in counting or recording the number of beans in a cup meant that the answer was far outside the acceptable range of 1600–1900.

2. About how many beans are there in the bucket?

75 per cup

|||| |||| |||| ||||

$\frac{1}{3}$

$10 \times 75 = 775$

The answer was not related to the question.

Activity 6: Packaging

Problem: You are working for Safeway. You need to make **as many packages as possible** containing both red and white onions. You are given two boxes with 24 red onions in one and 36 white onions in the other. The red onions and white onions need to be packaged in such a way that each bag will have the same number of red onions in each bag. The number of red onions and number of white onions need not be equal in each bag. Package these for Safeway.

Materials: 24 cubes of one colour
36 cubes of another colour
plastic bags

This solution was scored "Beyond Grade 9 Level."

1. How many packages of onions did you make?

I made 12 packages of onions.

The problem was analyzed and readily understood. There is evidence of the student finding the greatest common factor of 24 and 36. The student then divided 24 and 36 by this greatest common factor to find the solution. This was related to the number of the packages and how many of each type fit into the bag.

2. How many red onions and how many white onions did you put in each package?

There are 2 red onions in each package.
There are 3 white onions in each package

The conclusion was made in terms of the context: 12 packages with 2 red and 3 white in each.

The problem that we can use is G.C.F

$$12 \overline{)\, 24, 36}$$
$$2, 3$$

∴ We can make 12 packages of onions, 2 red and 3 white onions in each packages.

This solution was scored "At Grade 9 Level."

1. How many packages of onions did you make?

I made 12 packages of onions.

2. How many red onions and how many white onions did you put in each package?

I put 2 red onions and 3 white onions into each package.

The task was understood. There was no evidence of a workable strategy. However, the correct number of packages and of red and white onions was indicated. The student correctly answered each question in context.

This solution was scored "Not Yet At Grade 9 Level."

1. How many packages of onions did you make?

I made 4 packages of onions

2. How many red onions and how many white onions did you put in each package?

in each package I put 6 red onions & 9 white onions

The problem was partially understood. Terms like "as many as possible" were misunderstood. However, the student used a factor of 24 and 36. This led to the use of 6 and 9 as the number of onions of each colour. The answers were related to the questions asked.

Observations Regarding Students' Skills and Knowledge

Students who participated in the performance-based assessment were motivated and stayed on task for one to two hours. When an immediate strategy was not evident, 'Trial and Check' was used. In some cases, students needed reassurance that it was all right to use manipulatives. This implies that there was a lack of experience in using manipulatives to solve mathematical problems. Many students stayed after the assessment sessions to talk about the ways the problems could have been solved.

What students could do:

- In estimating, the students devised a variety of strategies all of which led to a good estimate. The majority of students preferred the counting estimation strategy over the grid-tray, layering, or population sampling strategies. The number of beans used was rounded to the nearest 100 or the number of cupfuls was rounded to the nearest 10. This made estimation a mental process.

- In using scale drawing, the students again devised a variety of strategies to measure the non-linear distance between two points. They used copper wire, rolling a penny, or measuring very small line segments. They were able to correctly use the scale and set up a proportion to find the actual distance.

- In the seating arrangement, most students used the manipulative model to solve the problem. They understood the meaning of "rectangular shape" and "no holes in the middle." Some students were able to connect this problem situation with the relationship between perimeter and area, where the area remained constant and perimeter varied. The dimensions of the rectangle had to be whole numbers.

- In solving the lateral surface area of the solar cylinder, students devised three methods for finding that area:
  a) the wrapping method
  b) the rolling-tracing method
  c) the surface area of the cylinder and $\frac{1}{2}$ surface area of half cylinder

  Many students who used the wrapping method realized that the upper lateral surface had the same area as a triangle. Measurement of the dimensions was well done. Most expressed the dimensions to nearest millimetre.

- In data management, the collection of data was well done. Many students were able to use these ordered pairs to plot the graph for this continuous information. Extrapolation was well done by those who extended their line graphs.

- In packaging, most students used manipulatives to solve the problem. Many of the students found the greatest common factor of 24 and 36 and used it to find the number of packages. This led to the number of each type of onions in each package.

Areas for improvement:

- In estimating, the students need to realize that it is a mental process requiring very little computation; answers such 1757.5 are not acceptable as an estimation. This indicates that estimation must be reinforced as a mental computation.

- In using scale drawing, some students did not use the scale to find the actual distance. They made the assumption that 1 cm = 1 km. Attention should be placed on use of scales.

- In the seating arrangement, several students were satisfied with one answer only. They did not investigate for all possible solutions. Activities that encourate alternative ways to solve a problem may help lead students to exploring alternative solutions.

- In solving the lateral surface area of the solar cylinder, many students tried to

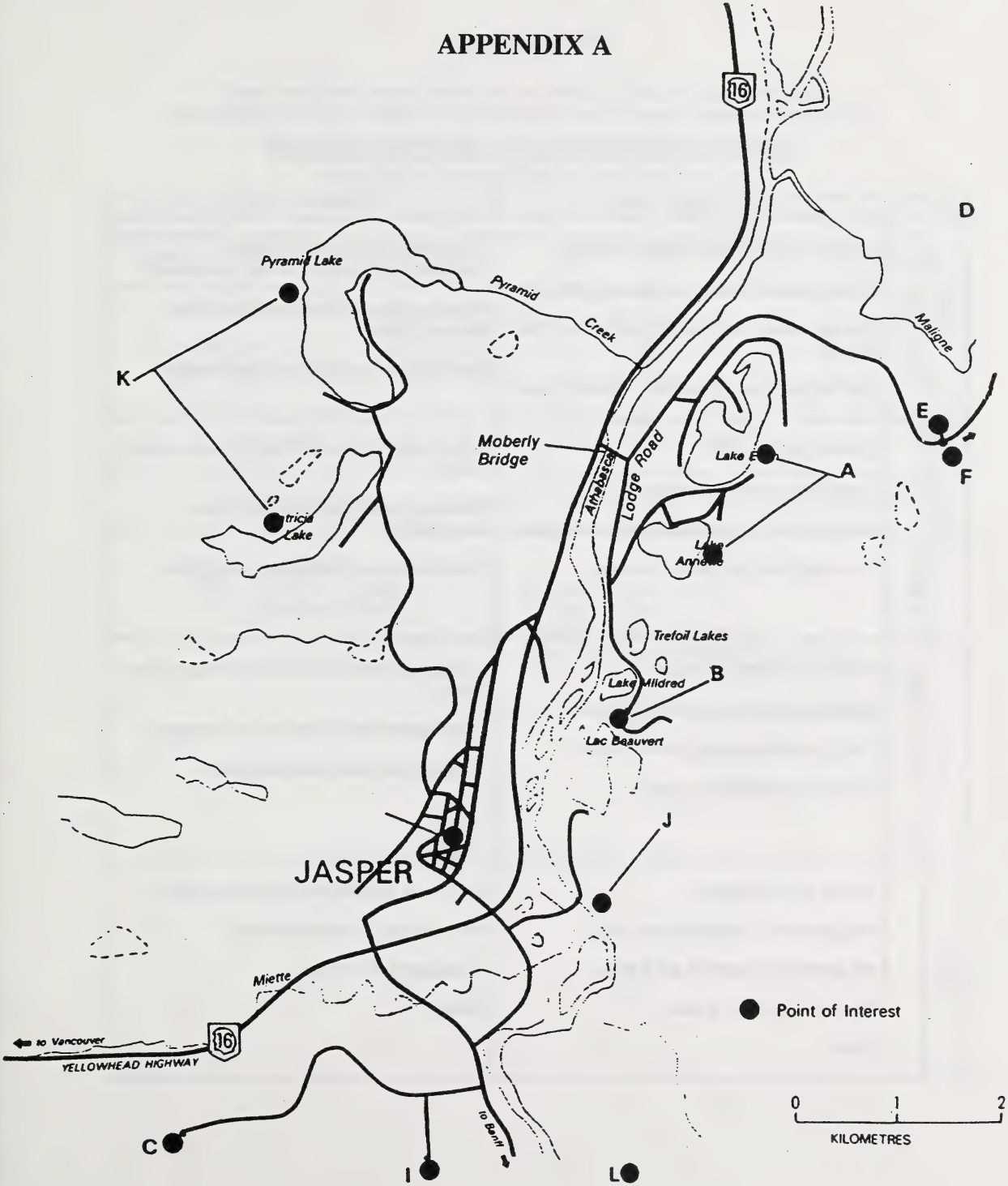
apply a formula for finding surface area. This they could not do because of the shape of the upper part of the cylinder. Many careless computations, such as $150.3 + 50.8 = 658.3$, indicated that students did not estimate for the reasonableness of their answers.

- In data management, the data recorded were not recognized by some students as continuous. Therefore, these students drew a bar graph. It is important for students to recognize the suitability of a graph based on the information displayed.

- In packaging, some students did not relate the greatest common factor and its other factor to solve the problem. The use of greatest common factor as a problem-solving strategy is very useful in problems such as the packaging problem.

Finally, feedback from the teachers of the students who completed the tasks indicated that the type of problems presented in these tasks were an excellent way for students to demonstrate approaches to problem solving. As well, these tasks can serve as a model for possible instructional activities in the classroom.

APPENDIX A


16
D
Pyramid Lake
Pyramid
Creek
Maligne
K
Moberly
Bridge
Lodge Road
Amphitrite
Lake E
A
E
F
tricia
Lake
Lake
Annette
Trefoil Lakes
Lake Mildred
B
Lac Beauvert
J
JASPER
Miette
Point of Interest
to Vancouver
YELLOWHEAD HIGHWAY
16
C
I
L
to Banff
0
1
2
KILOMETRES

APPENDIX B

MATHEMATICS PBA HOLISTIC SCORING CRITERIA

		PROBLEM SOLVING	COMMUNICATION
3	BEYOND	Analyzed and readily understood the task. Developed an efficient and workable strategy. Showed explicit evidence of carrying out the strategy. Synthesized and generalized the conclusion.	Rich, precise and clear all the time (mathematically correct, correct symbolism). Representation is very perceptive (chart, diagram, graph). Explanations are logical and appropriate.
2	AT LEVEL	Understood the task. Developed a workable strategy. Inferred (some evidence) but not always clear. Connected and applied the answer.	Appropriate most of the time, accurate, mostly clear. Representation is accurate and quite appropriate. Explanations are mostly clear and logical.
1	NOT YET AT	Partially understood the task. Appropriate strategy some of the time. Possible evidence of a plan - not clear. Partial connection of answer.	Appropriate some of the time, but may not be clear. Uses representation but not too precisely. Explanations have some clear parts.
0		Totally misunderstood. Inappropriate, unworkable strategy. No evidence of carrying out a plan. No connections of answer. Blank.	Unclear or inappropriate use of symbolism. Incorrect use of representation. Explanation is not clear. Blank.

APPENDIX C

These provincial results show the percentage of students demonstrating the different levels of performance for problem solving and communication skills.

	PERCENTAGE OF STUDENTS AT EACH LEVEL													
Performance Level	**Activity 1**		**Activity 2**		**Activity 3**		**Activity 4**		**Activity 5**		**Activity 6**		**All Activities**	
	PS	**C**	**PS**	**C**	**PS**	**C**	**PS**	**C**	**PS**	**C**	**PS**	**C**		
3	8.3	6.0	15.1	17.7	9.1	11.5	2.4	4.0	15.9	23.2	50.1	32.6	16.8	15.8
2	41.7	35.6	32.0	36.8	13.5	17.3	36.4	40.4	47.7	40.4	12.1	39.8	30.6	35.1
1	34.4	41.0	44.1	38.8	30.4	35.8	48.3	44.9	27.8	30.0	18.5	21.1	33.9	35.3
0	15.5	17.5	8.7	6.8	46.9	35.4	12.9	10.7	8.5	6.4	19.3	6.6	18.6	13.9

PS — Problem Solving
C — Communication

3—Beyond Grade 9 Level
2—At Grade 9 Level
1—Not Yet At Grade 9 Level
0—Totally Misunderstood or Left Blank